EXTRATERRESTRIAL FACTORS IN THE INITIATION OF NORTH AMERICAN POLAR FRONTS

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ABSTRACT

Begun as an effort to better delineate the effects of sunspots on North American polar front initiation, this study soon uncovered rather remarkable lunar-solar gravitational influences far outweighing the sunspot influences. Data used in the study included daily sunspot numbers since 1914, a daily calendar of lunar phases, and departures of Chicago mean daily temperatures from the daily normal. Sharpest Chicago temperature declines occurred 10 days following new or full moon reinforced by lunar perigee; the declines were smaller in the absence of lunar perigee, and they were at a minimum at the times of quarter moons and lunar apogee. These gravitational forces were found capable of negating or accentuating the effects of rising or falling sunspot numbers. Extension of this study to a broader observational basis should provide helpful information for greater accuracy in long-range weather forecasting.

1. INTRODUCTION

The present communication supplies evidence that lunar forces are relatively more dominant than solar in the initiation of North American polar fronts and the ensuing degree of temperature variability or storminess of the Temperate Zone areas of this continent. Some of the sharpest polar-front cold waves which Abbot [1] attributed to sunspot outbursts were instead directly associated with lunar phase influences. It now appears that sunspots are not as important as lunar phases in such weather features—that lunar influences seem in fact worthy to be further clarified and entered into long-range weather-forecasting techniques.

Whether lunar phases bear a significant relationship to North American rainfall directly, as contrasted to a relationship mediated through the cyclonic disturbances riding the fringes of the invading polar Highs, has not been considered in the present study. Merriman [2] in 1892 presented evidence that new and full moons are followed by increased rainfall as did Wallace [3] in 1930. More recently Brier [4] [5] and Brier and Bradley [6] have applied more exact analytical methods to more extensive series of data, thus obtaining a better quantitation of the relationship. Their studies provided no evidence as to whether the lunar influences acted directly and locally, however, or indirectly through an influencing of polar High initiation and of the cyclonic activity so commonly present at the forward edges of these invading polar Highs. The extent of the lag their graphs showed in the rainfall peaks after new and full moons tends to favor the latter as the more likely.

Polar fronts and the variability factor in the earth's weather have long been of major interest to the author, largely because of their seemingly close relation to the degree of climatic drive pushing man forward so energetically in certain regions and leaving him more sluggish in others. In many published articles and books during the past several decades, the author [7], [8], [9], [10] has provided indications of a poleward shifting of the temperate climates seemingly optimal for human energy and progressiveness. This shift is being accompanied by an outward encroachment of debilitating tropical stagnation. Such climatic shifting has involved a continued reduction in outer temperate storminess through the last half century, a reduction for which no apparent explanation is available. It was in a serious search for such an explanation that the marked lunar influences over the initiation of north polar fronts now to be described were discovered.

2. VARIABILITY OF CHICAGO TEMPERATURES TAKEN AS INDEX

With use of daily temperature data since 1914 from Chicago's University station (except for a few substitu-

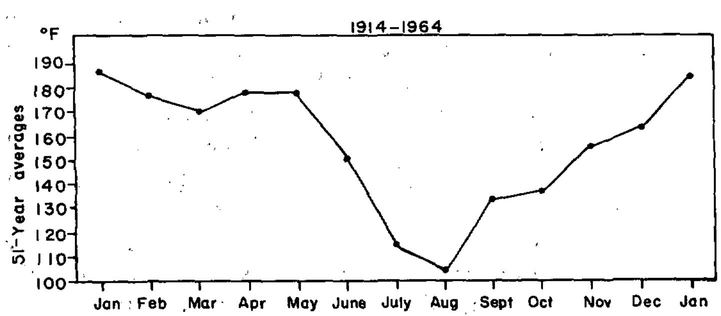

FIGURE 1.—Summed deviations from normal of Chicago daily mean temperatures (1914–1964), excluding deviations of 5°F. or less.

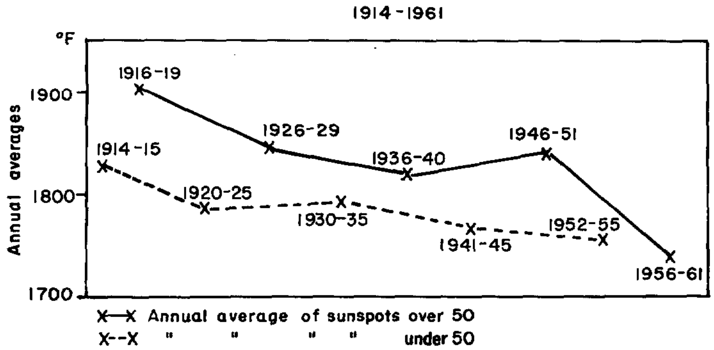

FIGURE 2.—Declining variability of Chicago temperatures through the last five major sunspot cycles (1914–1961)

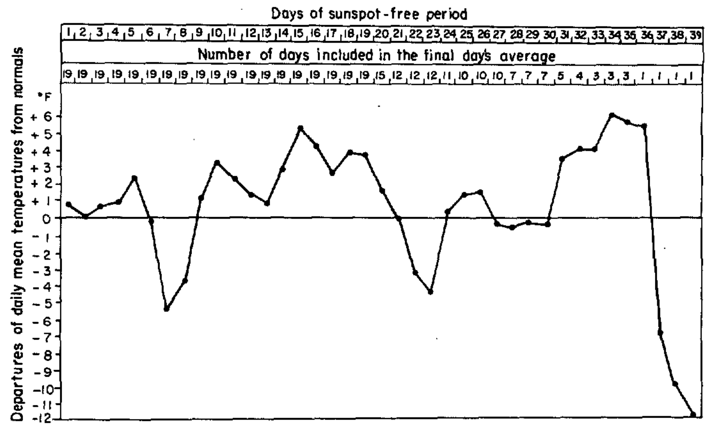

FIGURE 3.—Deviations of Chicago temperatures from normal (9-day lag) during sunspot-free periods.

tions from the Midway Airport station), deviations of the daily mean from the daily normal were tabulated alongside the daily sunspot numbers as published in *Astronomische Mitteilungen* (Zurich). Figure 1, plotted from only those periods when the daily mean temperature deviated either way by more than 5° F. from the daily normal, illustrates the marked seasonal swing in the monthly summed totals of such deviations averaged over the whole period (1914–1964). Such summed deviations averaged about 80 percent higher in January than in August, the January–August difference in mean values being 11.6 times its own standard error.

3. TEMPERATURE VARIABILITY THROUGH THE LAST FOUR MAJOR SUNSPOT CYCLES

Chicago temperature deviations of more than 5°F. either way from the daily normal were next summed separately for the more quiet and for the more active phases of the major sunspot cycles from 1914 to 1962; an annual average of 50 was used as the dividing line between quiet and active phases of the sunspot cycle. Figure 2 shows that the periods of low sunspot activity possess lesser average temperature variability across the normal than is found for the years of high sunspot activity. More important from the author's point of view, however, is the rather marked trend toward reduction of temperature variability in both high and low phases of the sunspot cycles down through this period of years.

Delving more deeply into the temperature-sunspot relationship on a daily or short-term basis we next related the deviations of Chicago mean daily temperatures from the daily normals to daily sunspot numbers, employing varying positive and negative lags. As Abbot had earlier found, the degree of positive association between daily sunspot numbers and daily temperature departures from long-term daily normals were so slight and inconstant as to have no more than a mere hint of significance—yet this was the type of evidence upon which Abbot had built his premise of sunspot importance. This lack of significant association was found to hold for all seasons of the year and for all levels of sunspot activity during the major sunspot cycles.

4. LUNAR PHASE EFFECTS WITH OR WITHOUT SUNSPOTS

It was during an attempt to establish normals for the daily temperature behavior over the sometimes lengthy periods of zero sunspots that a 15-day periodicity was encountered in the departures of Chicago's mean daily temperatures from the long-term daily normals (fig. 3) (based on 19 sunspot-free periods, table 1a). This at once suggested a lunar factor, and the course of the study was immediately shifted to this new basis.

In setting up a program of test data selection for this new phase of the study, consideration was given to the

TABLE 1.

(a) Starting dates for the 19 sunspot-free periods of figure 3.

1-10-1914	11-30-1923	8-13-1933	2- 3-1944	2-10-1954
2- 8-1914	1- 6-1924	11- 5-1933	4-18-1944	6- 3-1954
2-17-1923	3-24-1924	12-12-1933	2- 3-1953	3-10-1955
8- 1-1923	7-13-1933	1- 2-1944	1-12-1954	

(b) Zero dates for 24 sunspot-free periods of figure 4, with zero day falling midway between new and full moon (at quarter moons)

20 without lunar perigee				4 at perigee
1-18-1914	8-22-1923	11-24-1933	11-13-1953	1-28-1924
2-17-1914	3- 9-1923	12-24-1933	1-26-1954	5-15-1944
3- 3-1914	1-13-1924	2-16-1944	5-24-1954	12-13-1953
5-18-1922	6-30-1933	4-30-1944	6- 8-1954	6-23-1954
8-14-1922	7-29-1933	2-21-1953	3-16-1955	

(c) Zero dates for the 26 sunspot-free periods of figure 5, all zero days being at new or full moon.

21 without lunar perigee				5 with perigee
1-25-1914	2- 4-1924	12-31-1933	4-22-1944	3- 2-1923
2-24-1914	7-22-1933	1-10-1944	5- 8-1944	8-11-1923
7-13-1923	8- 5-1933	2- 9-1944	1-19-1954	11-13-1933
12- 7-1923	8-21-1933	2-24-1944	2-17-1954	12-17-1933
1-21-1924	12- 2-1933	4- 8-1944	6-16-1954	7-26-1953
			11-25-1954	

fact that lunar gravitational effects on the atmosphere at the earth's surface peak when the moon is in perigee, being then about ⅓ greater than at apogee. Lunar effects are reinforced by the solar at new and full moons and are at a minimum midway between when lunar and solar forces are in opposition. Solar gravitational effects at the earth's surface average 0.46 of the lunar. As a working hypothesis, it was presumed that periodic variations in the gravitational forces exerted on the atmosphere would tend to produce high-pressure ridges which over the North Polar regions might serve to initiate the moving polar fronts which so dominate temperature behavior in lower temperate latitudes—after the necessary buildup and travel time lag.

Restricting the first stage of the study to the sunspot-free periods in our 1914–1962 data, we first sorted out 24 dates (table 1b) falling midway between new and full moons—preceded by at least 5 days and followed by at least 6 days of zero sunspots—to represent minimal lunar gravitational effects during the lunar month. Four of these dates fell on or within four days preceding lunar perigee and are graphed separately. Figure 4 indicates the average deviation of Chicago mean daily temperatures from the daily normals, with a 10-day lag, through these 24 sunspot-free periods. The increased gravitational force at lunar perigee seems to exert a polar-front stimulation without the intervention of other lunar-solar influences, although small numbers rob the findings of statistical significance as shown in table 4.

Next came the sorting out from the same sunspot-free periods of 26 dates (table 1c) when the moon was new or full, 5 of these dates having the moon at or within 4 days preceding perigee. Curve 1 of figure 5 shows the rather mild effect of new or full moon (in conjunction with the sun, of course) on the 10-day lagged Chicago daily temperature deviations, and curve 2 the marked effect of adding thereto the developing or full-blown perigee influence.

5. LUNAR PHASE EFFECTS COMBINED WITH EFFECTS OF RISING OR FALLING SUNSPOT NUMBERS

Consideration was next given to the exercise of these lunar forces acting in conjunction with various levels of sunspot activity, starting with the years of low sunspot activity (1914, 1922–4, 1932–4, 1943–4, 1953–5). Use was made of 74 periods (table 2) of steadily rising sunspot numbers in which the rise amounted to at least 20 points in the 3 days preceding zero day (single point variations in sunspot numbers being disregarded). Curve 1a of figure 6 shows the 3° F. departure below the daily normals of Chicago temperatures taking place 9 days after an average rise of 35 points in sunspot numbers (curve 1) through the 5 days leading up to zero day. Curves 1 and 1a are based on 48 of the 74 periods (table 2), when zero day was 2 or more days away from new or full moon and when no lunar

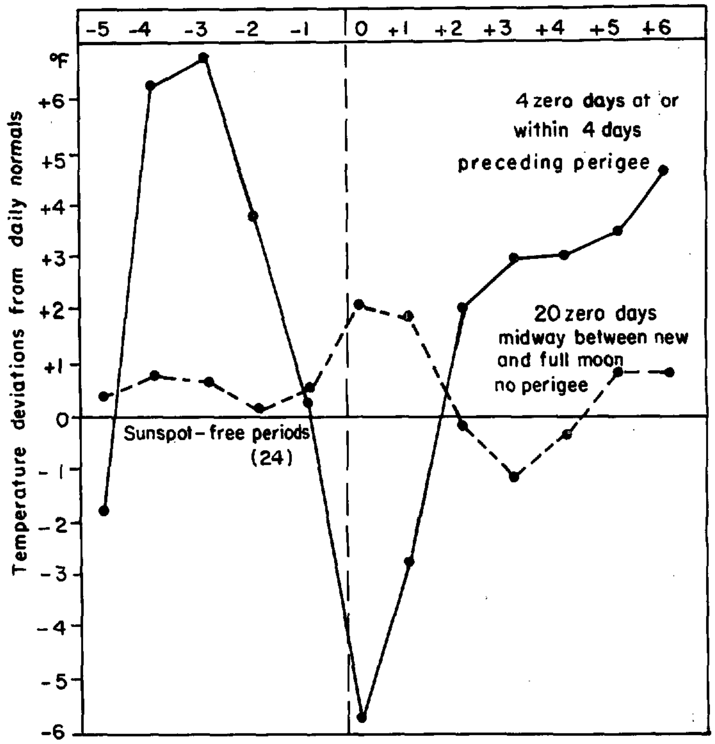

FIGURE 4.—Deviations of Chicago temperatures from normal (10-day lag) under minimal lunar-solar influence versus lunar perigee.

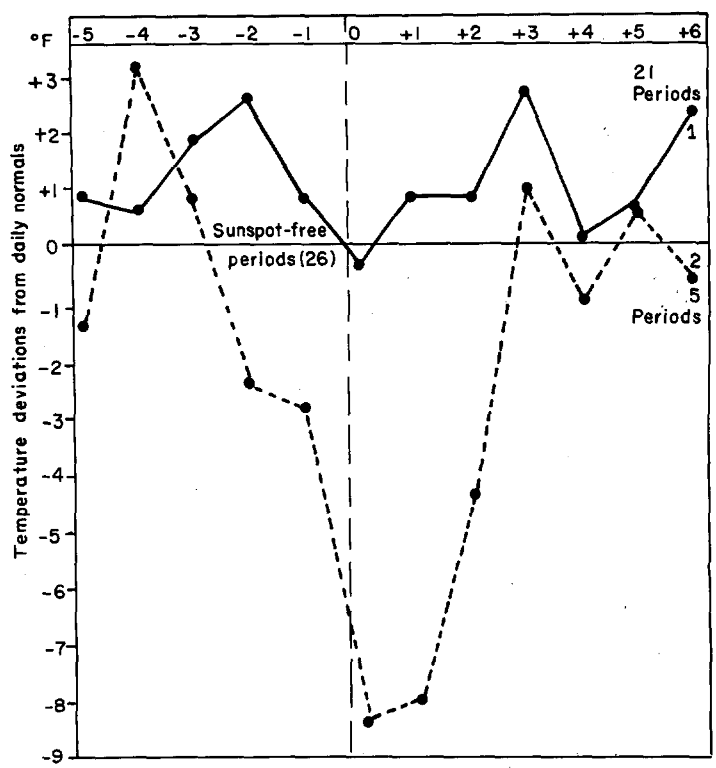

FIGURE 5.—Deviations of Chicago temperatures from normal (10-day lag) under new or full moon without (curve 1) and with (curve 2) lunar perigee.

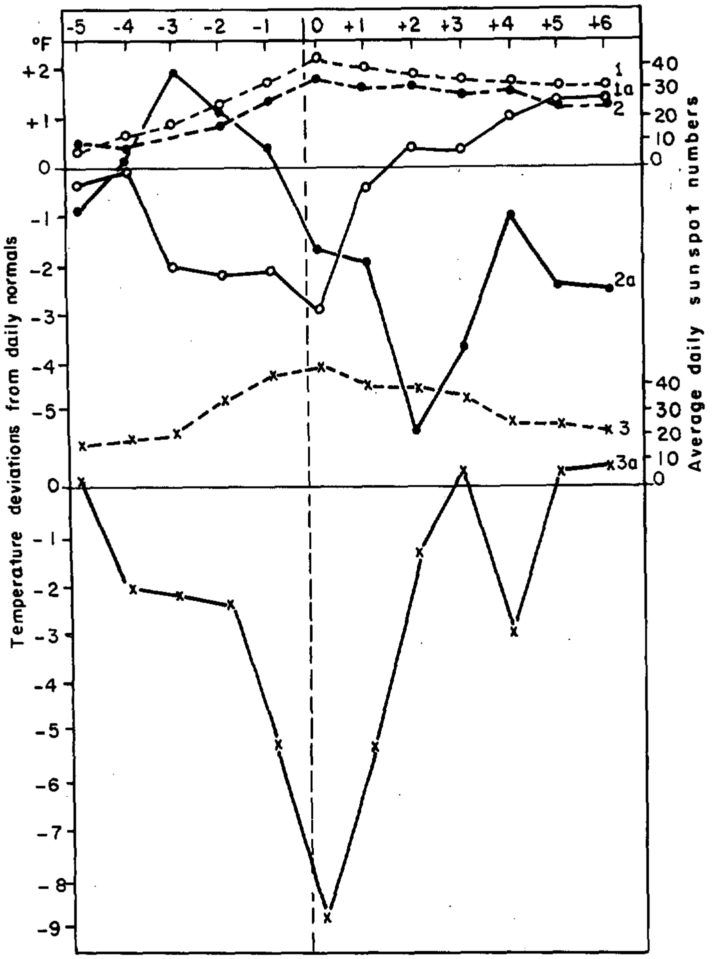

FIGURE 6.—Deviations of Chicago temperatures from normal (9-day lag) with new or full moon (curves 2, 2a), combined with lunar perigee (curves 3, 3a), and without either (curves 1, 1a).

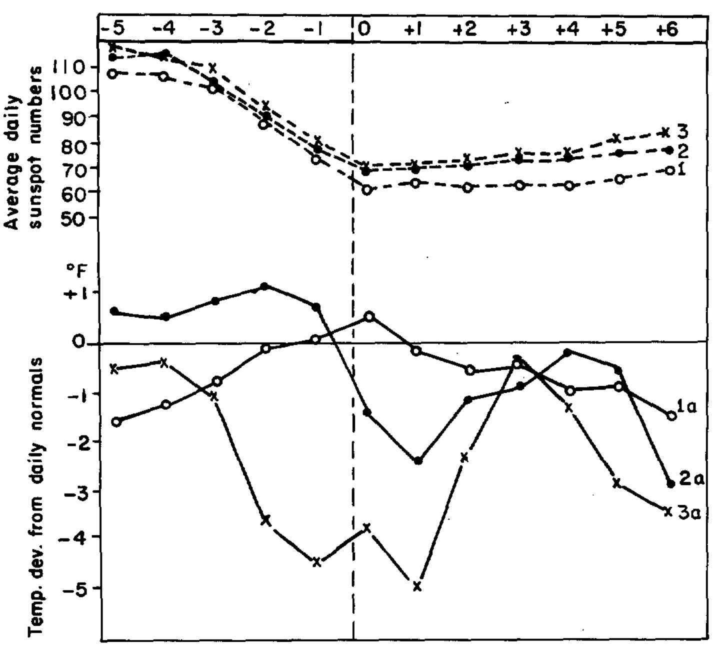

FIGURE 7.—Deviations of Chicago temperatures from normal (9-day lag) with falling sunspot numbers and new or full moon (curves 2, 2a), combined with lunar perigee (curves 3, 3a), and without either (curves 1, 1a).

TABLE 2.—*Zero dates for the 74 rising sunspot periods of figure 6.*

48 dates 2 or more days away from new or full moon, without perigee			26 within 1 day of new or full moon	
			14 without perigee	12 with perigee
4-19-1914	11-22-1932	4-26-1953	4-25-1922	3-12-1922
4-29-1914	2- 1-1933	6-15-1953	10-25-1923	3-20-1924
6-15-1914	4-16-1934	7-15-1953	7- 2-1924	4-20-1924
9-12-1914	5- 8-1934	8-12-1953	8-30-1924	5-15-1924
10-21-1914	5-17-1934	3-16-1954	10-10-1924	3- 9-1934
2-28-1922	6-17-1934	10-16-1954	6- 7-1932	3-18-1943
3-26-1922	11-29-1934	4-30-1955	6-19-1932	9- 9-1943
8-25-1922	1-19-1943	7- 2-1955	3-26-1933	3-20-1944
12-26-1922	2-23-1943	7-31-1955	3- 7-1943	2-25-1955
9- 4-1923	7- 9-1943	8- 8-1955	3-21-1943	10- 4-1955
9-27-1923	8-19-1943	8-29-1955	10-17-1944	11-28-1955
8- 3-1924	11-16-1943	9-25-1955	3-31-1953	5-19-1955
9-12-1924	12-18-1943	10-23-1955	11-11-1954	
2-27-1932	8- 9-1944	11-11-1955	1- 7-1955	
8-27-1932	9-13-1944	12-21-1955		
10-20-1932	12- 9-1944	12 30-1955		

TABLE 3.—*Zero dates for the 225 falling sunspot periods of figure 7*

114 dates midway between new and full moon, no perigee			111 dates *with* new or full moon		
			74 without perigee		37 with perigee
2- 2-1915	3-18-1929	8-27-1948	6-26-1915	12- 3-1941	6-29-1916
3-22-1915	1-27-1930	9-25-1948	8-10-1915	12-18-1941	6- 5-1917
7- 4-1915	12- 2-1930	6-19-1949	2-18-1916	6-25-1945	7- 4-1917
4- 9-1916	6-23-1935	9-30-1949	7-29-1916	11- 4-1945	8- 2-1917
6- 8-1916	10-20-1935	2-24-1950	9-26-1916	8-26-1946	12- 6-1919
12-16-1916	2-19-1936	5-10-1950	4-21-1917	11-23-1946	5-17-1920
1-15-1917	4-29-1936	6- 7-1950	8-17-1917	8-16-1947	1-14-1926
3-29-1917	11-21-1936	10-18-1950	10-29-1917	9-14-1947	7-14-1927
4-29-1917	12- 6-1936	12-17-1950	6- 8-1918	11-16-1948	9-29-1928
9- 8-1917	1- 5-1937	3-15-1951	11- 3-1918	1-29-1949	10-28-1928
12- 6-1917	4- 3-1937	3-30-1951	12-17-1918	4-28-1949	10-18-1929
1- 4-1918	4- 2-1938	4-29-1951	2- 4-1919	5-12-1949	3-23-1936
4-18-1918	3-28-1939	5-28-1951	4-14-1919	8- 8-1949	5-20-1936
5-19-1918	7-24-1939	10-23-1951	5-14-1919	12- 5-1949	3-12-1937
6-15-1918	8-22-1939	1- 5-1952	5-29-1919	5-31-1950	6- 8-1937
10- 2-1919	10- 5-1939	4- 2-1952	8-25-1919	6-29-1950	5-29-1938
10-16-1919	3-31-1940	6- 1-1952	2-14-1920	8-27-1950	1-24-1940
7- 2-1920	8-26-1940	9-12-1952	11-10-1920	11-24-1950	6-19-1940
8-20-1920	9- 9-1940	12-24-1952	11-29-1921	8-17-1951	9-21-1941
10-18-1920	9-24-1940	3- 4-1956	8- 8-1926	2-25-1952	2-16-1946
3-31-1921	6-16-1941	4- 3-1956	10-21-1926	4-24-1952	5-30-1946
4-30-1921	7-15-1941	1- 9-1957	12- 5-1926	9- 4-1952	10-29-1947
4- 1-1925	8-15-1941	12-28-1957	12-30-1929	2-26-1956	2-24-1948
4-16-1925	5-22-1942	3-20-1958	2-17-1930	4-25-1956	7- 6-1948
6-14-1925	9- 2-1942	4-12-1958	4-18-1930	9- 4-1956	9-22-1949
3-22-1926	5- 4-1945	12-19-1958	6-16-1930	1-30-1957	2- 2-1950
12-27-1926	5- 9-1946	4-30-1959	5-18-1935	3-16-1957	1-16-1951
3-26-1927	11-30-1946	5-15-1959	9-12-1935	8-10-1957	5-21-1951
7- 7-1927	12-31-1946	1- 8-1961	12-13-1935	11- 7-1957	7- 7-1952
9-18-1927	1-29-1947	4-22-1961	1- 8-1936	1-19-1958	3-24-1958
10-18-1927	3-15-1947	5- 7-1961	6- 5-1936	2-18-1958	8-15-1958
12-17-1927	4-13-1947	8-18-1961	6-12-1938	6-17-1958	10- 2-1959
1-30-1928	6-11-1947	12-30-1961	9- 9-1938	10-27-1958	3- 2-1961
5-12-1928	6-26-1947	3-28-1962	11-22-1938	11-11-1958	6-28-1961
6-10-1928	7-25-1947	10- 5-1962	1- 9-1940	4- 8-1959	12- 7-1961
7-25-1928	8-23-1947	10-20-1962	3- 9-1940	2-15-1961	2- 5-1962
10- 6-1928	5-16-1948	11-20-1962	8-17-1940	12-11-1962	3- 6-1962
12-19-1928	8-12-1948	5-29-1959			

perigee occurred on that or any of the 4 preceding days. These curves do not differ materially from those based only on zero days falling 7 or 8 days away from new or full moon. They can thus be taken to represent the more or less uncomplicated effects of rising sunspot numbers alone.

Curves 2 and 2a of figure 6 cover 14 of the 74 periods (table 2) when zero day fell on or within 1 day of new or full moon but safely away from lunar perigee effects. Curves 3 and 3a cover 12 of the 74 periods (table 2) when lunar perigee occurred on or within 4 days preceding zero day, and a new or full moon on or within the 6 days im-

TABLE 4.—*Significance tests on observed Chicago temperature deviations*

Reference		N	Departures of 0-day daily means from normal		Diff. of means (° F.)	Standard error/diff.	t	p
Figure	Curve		Mean (° F.)	S.D.				
4	1	20	+1.75	3.65	7.25	6.34	1.41	0.3
4	2	4	−5.50	5.17				
5	1	21	−0.52	7.38				
5	2	5	−8.00	10.49	7.48	4.96	1.51	0.1
6	1a	48	−2.69	8.44 (1a vs 2a)	2.36	1.76	1.34	0.2
6	2a	14	−5.04	4.73 (2a vs 3a)	4.21	2.34	1.80	0.1
6	3a	12	−9.25	6.81 (1a vs 3a)	6.56	2.31	2.80	0.01

mediately preceding or the 3 days immediately following zero day. Curves 2 and 2a thus represent the effects of adding the lunar-solar forces of new or full moon to the rising sunspot effects. In curves 3 and 3a there is further added thereto the lunar perigee influence, somewhat blurred by lack of exact conjunction in the occurrences. Rising sunspot numbers alone were followed by a mean Chicago temperature depression of 2.69° F. (curve 1a); addition of the new or full moon effect was followed by a doubling of this temperature depression to 5.04° F. (curve 2a), and the further addition of lunar perigee by a tripling to 9.25° F. (curve 3a). Table 4 shows that adequate numbers bring these changes into the range of statistical significance.

Attention was next turned to periods of falling sunspot numbers, using as zero days 225 dates (table 3) during the remaining years of intermediate and high sunspot activity of our 1914–1962 data. Included were only those periods when sunspot numbers declined steadily and by at least 30 points during the 3 days leading up to zero day (curves 1, 2, and 3 of fig. 7). Single point variations in sunspot numbers were again disregarded. Curve 1a of figure 7 shows the 2° F. average rise in Chicago daily temperatures following by a 9-day lag the falling sunspot numbers (curve 1) in 114 of the 225 periods (table 3) when zero days were 7 or 8 days away from new or full moon and free of lunar perigee influence. At the 74 times of new or full moon this 2° F. rise was turned into a 3.5° F. fall (curve 2a), and this fall was further increased by the addition of lunar perigee influence (curve 3a). Table 4 shows these temperature changes to be of high statistical significance.

In order to test the increased solar gravitational effects at the time of winter as contrasted to summer solstice, use was made of the 13 December–January (curves 1 and 1a of fig. 8) and the 9 June–July (curves 2 and 2a of fig. 8) zero dates listed in columns 4 and 5 of table 3. These curves of figure 8 provide only a hint of a greater downturn from normal in Chicago temperatures following the winter new or full moons in the absence of lunar perigee, although a larger number of dates will be needed before a statistically significant relationship can be established.

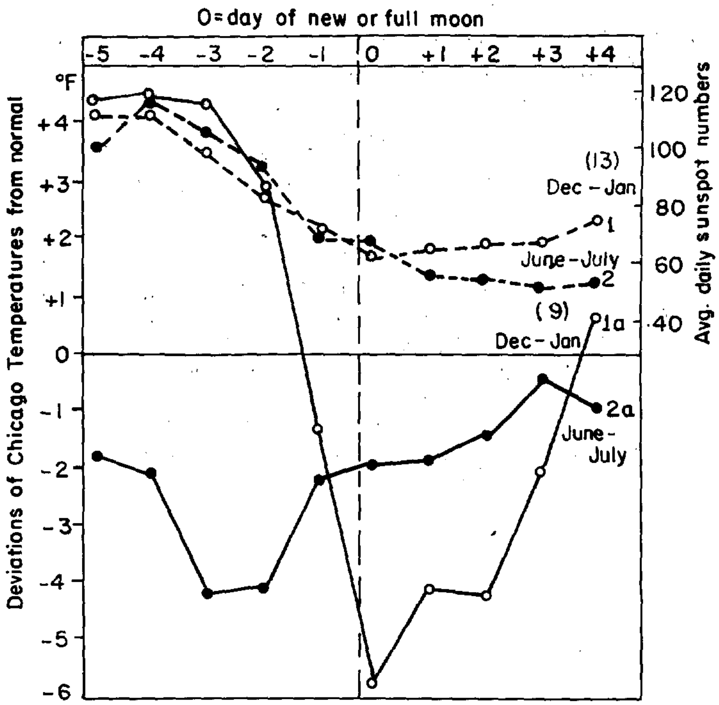

FIGURE 8.—Deviations of Chicago temperatures from normal (9-day lag) with declining sunspots and new or full moon but without perigee (December-January versus June-July data from columns 4 and 5 of table 3).

6. DISCUSSION

The findings here presented suggest strongly that lunar-solar gravitational forces exert important influences over the generation of North American polar fronts and the subsequent declines in daily temperatures in middle temperate latitudes. These influences seem to be minimal at times midway between new and full moons and in the absence of lunar perigee. New or full moons tend to bring sharp temperature declines, and these declines are greatest when the influence of lunar perigee is added thereto. These gravitional forces seem able to negate or accentuate the effects of rising or falling sunspot numbers. It is remarkable that these extraterrestrial gravitational influences should show up amid the very dynamic conditions otherwise prevailing in the atmosphere of the rotating earth. It is possible that similar influences could be demonstrated also for the other major planets of the solar system, although maximal influences of them all simultaneously applied would be of a magnitude smaller than that of lunar perigee alone.

It would seem desirable that the present limited study be extended to include other key stations and other sunspot-free periods in the low phases of major sunspot cycles back beyond those we have used. The present communication is offered only to point out the interesting possibilities of this approach to an understanding of

North American weather variability. A later communication will extend this type of approach to the initiation of tropical cyclones.

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[*Received Sept. 3, 1965; revised Mar. 3, 1966*]